Republic of Armenia
Urban Heating Strategy
Summary Report and Recommendations

Energy and Infrastructure Department
Europe and Central Asia Region
The World Bank

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Contents

FOREWORD AND ACKNOWLEDGEMENTS

The Government of Armenia (GOA) has recognized for some time that:

(i) household expenditures for winter heating are a significant source of poverty, particularly in urban areas as the housing construction offers few alternatives for affordable and safe heating;

(ii) the continued provision of district heating by public entities to about 10% of the population, with virtually no enforcement of payment, constitutes an unfair "subsidy" to consumers and lacks accountability on the part of the service providers; and

(iii) excessive reliance on costly electricity for heating has high economic costs and will be increasingly unaffordable as tariffs are adjusted to cover high costs of asset replacement, particularly when the Medzamor nuclear power plant is retired; and

(iv) easy access to affordable and safe heating services will help create a healthy and productive environment necessary for poverty alleviation.

Therefore, as part of its Poverty Reduction Strategy, the GoA undertook to prepare an Urban Heating Strategy (UHS) to facilitate access to efficient, clean, safe and affordable heating services.

Preparation of the strategy was initiated in early 2001 under the leadership of the Ministry of Finance and Economy which combined a variety of initiatives and funding sources to help prepare this strategy. **The Government adopted the UHS on September 5, 2002 (Decree 1384 N).**

Donors who funded key elements of preparation included:

EU TACIS which funded a team of national and international consultants (led by Environmental Resources Management (ERM)) to prepare a household survey on energy and heat demand, prevailing coping mechanisms and impact on household expenditures and health, ability and willingness-to-pay for improved heating services, and attitudes towards different institutional options for service provision.

The **Energy Sector Management Assistance Programme** (ESMAP), a global technical assistance program sponsored by the World Bank and the United Nations Development Programme (UNDP) and managed by the World Bank, provided a grant for a study on the "Development of Heat Strategies for Urban Areas of Low-income Transition Countries." This grant funded the Consultant (a consortium of COWI A/S and Ramboll of Denmark) to provide the methodological framework for preparing the strategy in Armenia and the Kyrgyz Republic (and also the development of the Kyrgyz urban heating strategy).

A **Japan Government** grant provided under the World Bank administered Policy and Human Resource Development (PHRD) program funded pre-feasibility studies on the urban heating and gas infrastructure and institutional arrangements.

Studies focused on the cities of Yerevan, Charentsavan, Gyumri and Jermuk, representing the four climatic zones in Armenia and covering the bulk of the urban population. Work on heating options was led by COWI while the work on identifying priority investments in the gas sector (to support the UHS) was led by Yerevan Project. Both studies involved local and international consultants.

The PHRD grant also supported the Project Implementation Unit which coordinated the work of consultants under the leadership of an inter-sectoral Project Management Board headed by the Ministry of Finance and Economy (Deputy Minister M. Mikaelyan). The consultant reports were discussed in several workshops in Yerevan during 2001 and 2002 with experts from central and local governments, government agencies, academia, international organizations, NGOs and the private sector. During the final workshop in March 2002, all participants expressed broad agreement with the presented UHS objectives and actions. It is expected that the GOA will request World Bank support for implementation of the UHS under an Urban Heating Project (UHP).

Valuable support was also provided by the **United States Agency for International Development** (USAID), its Consultants, and UNDP. Preparation of the UHS benefited from on-going activities under the UNDP-managed "Removing Barriers to Energy Efficiency in Municipal Heat and Hot Water Supply" funded by a grant from the Global Environmental Facility (GEF), executed by the Ministry of Nature Protection, and under the USAID-funded "Electricity and Natural Gas Sector Reform Program" and "Energy Efficiency & Renewable Energy Resources Development", led by its Consultants PA Consulting Group and Advanced Engineering Associates International, respectively.

The World Bank team supporting the UHS development consisted of Salman Zaheer (Task Team Leader), Anke Meyer (Energy Economist), Lev Freinkman (Senior Economist), David Craig (Energy Sector Manager), Owaise Sadaat (Resident Representative), Surekha Jaddoo (Operations Analyst), Julian Lampietti (Senior Social Sector Specialist), Alexander Astvatsatryan (Technical Specialist), Gevorg Sargsyan (Infrastructure Officer), Josephine Kida (Program Assistant), and Albert Zweering (Consultant, supported by a grant from the Dutch Consultant Trust Fund)..

ABBREVIATIONS AND ACRONYMS

AMD	Armenian Dram
CH	Centralized heating
CHP	Combined heat and power (also referred to as cogeneration)
DH	District heating
GDP	Gross Domestic Product
HOB	Heat-only-boiler
HTW	Hot tap water
kWh	Kilowatt hour
MWh	Megawatt hour
PIU	Project Implementation Unit
UHS	Urban Heating Strategy
USD	United States Dollar
WB	World Bank

EXCHANGE RATE

1 USD = 550 AMD (2001 average)

DEFINITION OF TERMS

Centralized heating:	A heat supply system where heated water for space heating purposes is distributed from a central heat source (normally a CHP or HOB plant) through a pipe network, *and* where administration, operation and billing are also centralized. The term *district heating* is often used instead.
Autonomous heating:	A heat supply system with a decentralized heat source (normally a small HOB at micro-district or building level) which supplies the apartments in one or a couple of buildings and which is administered and operated by an autonomous entity – e.g. a private heat provider or a condominium.
Individual heating:	Heat supply that is specific for the individual house or apartment and not necessarily shared with neighbors. Both apartment gas stoves and electric heaters are considered individual heating solutions even though the primary energy is transmitted to the consumer through a common network. Wood stoves are the third main individual heat source in Armenia.

CHAPTER 1. INTRODUCTION

During the 1990s, most of the district heating systems which had supplied winter heating and year-round hot water in the towns and cities, to at least 50% of the country's population, fell into disrepair due largely to the effects of the economic blockade. Since the mid-1990s, national and urban authorities have restored district heating services to eight municipalities, attempting to cut supply costs, charge cost-reflective tariffs and enforce payment. This has helped reduce somewhat the fiscal burden and asset depletion associated with this heating service, but cost recovery has remained unsustainable. As a result, less than 10% of the population currently receive heat from district systems. However, even this restricted supply is provided in a non-commercial manner with virtually no accountability for supply or consumption (for example, absence of any metering) and weak mechanisms for enforcing payment. Non-payment amounted to about US$10-12 million annually (about 0.5% of GDP) until a few years ago and resulted in the central government having to clear arrears of the heating companies to their fuel suppliers.

The rest of the population (more than 90%) resorts mostly to individual heating solutions such as electric heaters or fuelwood stoves in urban and rural areas, supplemented by dung and waste in rural areas. Electric heating is expensive and enjoys a high degree of payment enforcement, making it an option only for the relatively better off. The urban poor are left to burning fuelwood, often in apartment buildings constructed without adequate ventilation for wood burning, with detrimental health implications and accelerated deforestation of already strained forestry resources. On the positive side, consumption of both electricity and wood can be easily controlled to match income constraints and comfort preferences.

Methodology for Developing an Urban Heating Strategy. Recognizing that heating is a local issue, typically dependent on local climatic conditions, housing density, and natural, human and financial resources, the Government selected four cities - Yerevan, Charentsavan, Gyumri and Jermuk - for the development of individual heating strategies from which to crystallize a national Urban Heating Strategy (UHS). The cities lie in different geographical zones of the country, Yerevan having the mildest climate and Gyumri/Jermuk the coldest.

The *methodology* for developing the heating strategy consisted of:

(a) an assessment of *coping strategies* of households. A demand assessment was carried out on the basis of two household surveys (1999 and 2001). The second survey which concentrated on the four target cities listed above, included also an environmental and health component;

(b) A *technical-economic assessment* of supply options. This was carried out in two phases.

- First, a *baseline* was established, estimating the costs of providing heat from the existing infrastructure in the short and medium term without any further investments. Also investigated was the institutional environment in which heat supply takes place and which constitutes powerful barriers to the sustainable provision of heat. The results were presented and discussed at national workshops to reach a consensus before starting the second phase.

- Second, the costs of different options for providing heat over the long term were estimated, assuming necessary investments in heat and gas supply infrastructure. Feasible supply options were identified based on their ability to provide heat at a cost that is affordable to a large part of the population (as revealed through the consumer surveys).

(c) Outlining a *phased implementation strategy*. The strategy recommended actions, especially actions which can be taken in the short/medium term to eliminate institutional and information barriers that are preventing consumers from accessing affordable heating services and suppliers from offering these services in an innovative, safe and sustainable manner.

At a final workshop in March 2002, the outlined strategy was presented and discussed and its conclusions were largely agreed on by different parts of the Government, and with the development partners.

Report Structure . This report presents the Urban Heating Strategy for Armenia largely based on the consultant reports listed in Annex 1.

- Chapter 2 provides a brief historical perspective of energy resources and consumption in Armenia, in particular the changing nature of heating.
- Chapter 3 summarizes the social and demand assessment, including the current coping methods, willingness-to-pay for different supply options, and attitudes and preferences for different institutional arrangements for the provision of heat.
- Chapter 4 describes the current heat supply structures, including assessments of the technical, financial, fiscal, institutional (supply, regulatory and consumer arrangements) and environmental aspects.
- Chapter 5 identifies technically, economically, environmentally and socially feasible supply options and the market conditions needed to facilitate sustainable access to each of these supply options.
- Chapter 6 offers World Bank recommendations and next steps for successful implementation of the strategy.

CHAPTER 2. HISTORICAL PERSPECTIVE OF ECONOMIC ACTIVITY AND ENERGY CONSUMPTION

Economic Environment. Following the break-up of the Soviet Union in the early 1990s, Armenia's economy suffered one of the severest contractions among transition economies. The main causes were: the conflict in Nagorno-Karabakh and the related blockade of major transportation routes; an inherited economic structure which proved to be uncompetitive; the hyperinflation of 1992-93 and the continuing effects of the massive 1988 earthquake. In 1993 the country was in very serious difficulties, with more than 300,000 refugees and internally displaced people, electricity available, if at all, for only 2-3 hours a day, a collapse in other network-based infrastructure services, and perhaps two-thirds of the population surviving on humanitarian assistance. While the economy has since recovered significantly, output in 2000 was still less than 70% of Armenia's pre-transition peak. More importantly, recent economic growth has not brought many tangible social gains. Poverty and unemployment remain extremely high (Box 1), and surveys suggest that the public does not have enough confidence in the benefits of market-driven economic reforms. Emigration, particularly among the younger and better educated, continues at a fast pace for such a small economy.

Box 1: Poverty In Armenia

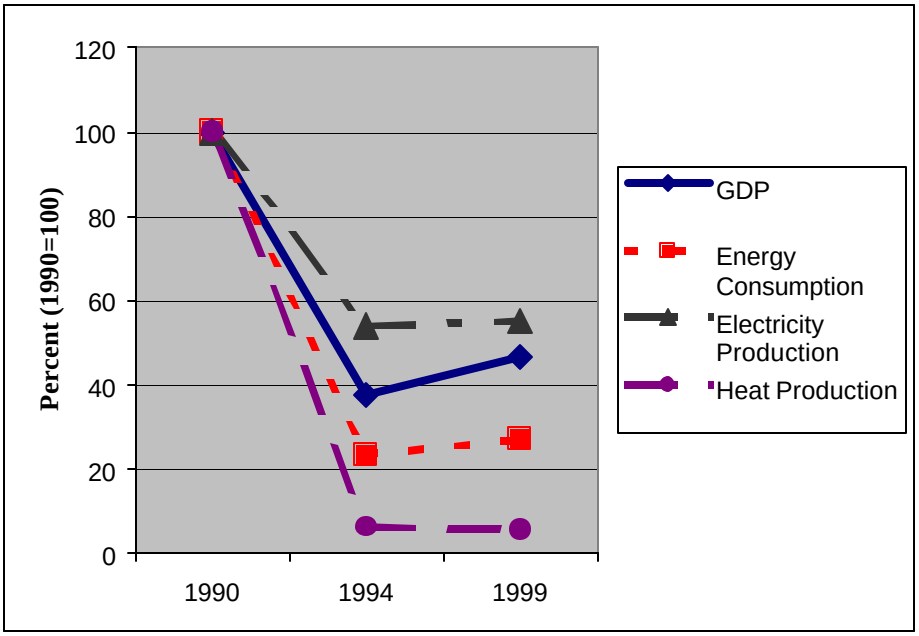
Poverty is widespread in Armenia. Preliminary results from the 1998/99 Integrated Household Survey suggest 55% of people live below the national poverty line (defined in terms of nutrition and other basic needs). The survey and other sources reveal a number of features of poverty in Armenia:

- Poverty in Armenia is particularly prevalent among the uneducated, unemployed, disabled, and families with several children, as well as in rural areas among the landless. In urban areas 58% of the population is below the poverty line, compared with 51% in rural areas. Poverty is especially severe in towns in the earthquake zone, with 75% of people in urban Shirak district being poor.
- However, absolute poverty (defined in terms of minimum nutritional needs) appears to have declined since the 1996 Household Survey, especially in urban areas. In 1998/99 extreme poverty was only half a percentage point higher in urban than in rural areas.
- Introduction of the new targeted family poverty benefit (which transferred 1.5% of GDP to the poorest 40%) was one factor that reduced extreme poverty.
- Survey results indicate relatively low consumption inequality: the consumption Gini is 0.37, indicating a moderate level of inequality, while the expenditures of the richest decile are estimated at eleven times that of the poorest. The poverty and inequality situation will be further explored and updated in the forthcoming Poverty Study (FY02).
- Overall indications are that poverty might be becoming entrenched in Armenia, with early signs that the poor may have started disinvesting in human capital. Poor families have difficulties maintaining their children at school – in some cases choosing to place their children in residential institutions. There are also some indications that poor children cannot attend school regularly because they have to work to support their families.
- With very limited supply of free of charge health services, access of the poor to basic health care has deteriorated, notwithstanding efforts to provide a basic health benefit package free of charge.

Source: 1996 and 1998/99 Integrated Household Surveys

Energy Consumption. Economic activity and energy consumption peaked in 1988. Between 1990 and 1999, per capita GDP (in USD) dropped from USD 2,370 to a mere USD 490. During this period total energy consumption fell by 73%, electricity generation by about 50%, gas use by 73%, and heat generation (for residential and industrial purposes) by 94%. Most of the decline occurred until 1994 and has since stabilized (Figure 1). During the same period, wood consumption has seen an unprecedented increase, accounting now for an estimated 10% of energy consumption.

Figure 1: GDP and Energy in the 1990s (1990=100)



Source: Based on Ministry of Nature Protection 2001.

Urban Environment. More than two-thirds of the total Armenian population of 3.7 million[1] live in urban areas, and about half of the urban population lives in high-rise buildings (3 floors and higher). Until 1991, district heat (DH) supply was provided in 55 municipalities in Armenia, heating 14 million square meters (sqm) of a total of 40 million sqm of residential space, and a large number of public buildings such as schools and hospitals. With the economic blockade, rise in fuel prices and decline in GDP, all supply was discontinued by 1993-95. By the end of the 1990s, eight municipalities had restored some DH supply (10% of total residential building area; Ministry of Urban Development 1999), but were struggling to make this service financially viable.

Energy Sector Institutions. During the crisis period between 1990 and 1994/95, power and district heating services were managed by the central government under a supply rationing regime. Since 1996, municipal heating companies have been managing the production of district heat (hot water) from heat-only boilers (HOBs) and its distribution. DH production from the combined heat and power (CHP) plants in Yerevan and Hrazdan is managed by the respective power generation joint stock companies (under the Ministry of Energy). The large Maisian HOB

[1] From the 1990 level of 3.7 million, the Armenian population has decreased to only 3.0 million now due to large-scale emigration. UN 2001, "Human Development Report: Armenia".

in Gyumri is also still under the Ministry of Energy (on account of its inability to secure fuel supply on a commercial basis). The Yerevan Thermal Power Plant also manages the distribution of DH to parts of the city connected to its production plant[2].

The Energy Law (1997) established the Energy Commission, tasked with licensing of energy suppliers and tariff-setting based on recovery of reasonable supply costs.

Heating tariffs. Until the early 1990s, charges for DH were recovered from a "tax" for communal services paid by households. Subsequently, specific DH charges were set based on the size of the apartment. Tariffs have been increasing towards cost-recovery levels since the Energy Commission was established in 1997, however, DH suppliers may (and sometimes do) charge tariffs below those approved by the Commission.

Inadequate environment for commercial provision of DH. Collections from consumers in 1998/9 averaged only 10% of production costs, leaving about US$10-12 million annually to be explicitly or implicitly subsidized by the government. As related in detail in chapter 4, DH is supplied and consumed very inefficiently, since heat production and distribution facilities as well as buildings are run down due to lack of funds, and consumption is not metered.

Alternative sources of heat. Most urban households without DH supply have electricity or wood-based heating for which they pay the full financial cost[3] and are usually disconnected for non-payment. Some households use natural gas which is priced at cost-recovery levels but with a mixed record of payment enforcement (even though supply is managed by a joint venture between an Armenian state-owned entity, a Russian public-private joint venture entity, and a private company). Poorer families typically rely on simple woodstoves for heating, with improvised ventilation in apartment buildings. Households in rural areas use electricity as well as kerosene, wood, and dung for their heating needs.

[2] This is on account of the Municipal Company's inability to collect tariffs and pay for the heat produced by the power plant, giving the latter the chance to experiment with various schemes to improve payment collection.

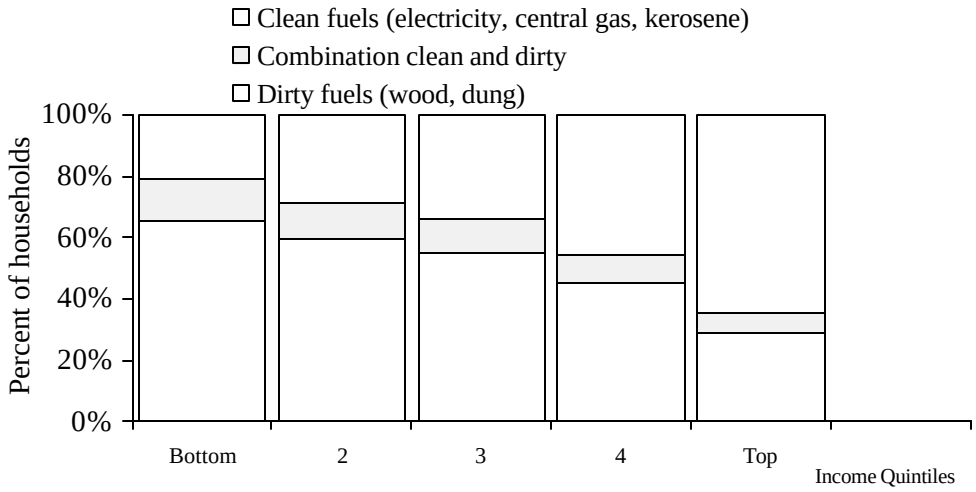
[3] In the case of electricity, tariffs cover operation and maintenance costs, but not full financial or capital costs. Fuel wood prices are unregulated but do not cover environmental costs.

CHAPTER 3. SOCIAL ASSESSMENT AND DEMAND FOR HEAT

3.1 CURRENT COPING MECHANISMS: HEATING FUELS AND EXPENDITURES

According to a 1999 household survey[4] in Armenia, 11% of the urban poor are connected to functioning district heating (DH) networks compared with 14% of the urban non-poor, reflecting the relatively even spread of income groups within most urban neighborhoods. For those households not connected to functioning DH networks, where family income influences heating choice, the poor are more likely to use wood, dung or other relatively "dirty" fuels, while the non-poor rely on clean fuels such as electricity and natural gas. Figure 2 shows the heating fuel choices of Armenian households not on DH networks.

Figure 2 Urban household heating fuel choices by income quintile



Note: Excludes district heating.
Source: Calculations from 1999 household survey data; see Lampietti/Meyer 2002.

The same survey indicates that energy consumed for space heating accounts for about 45 percent of an urban household's annual energy consumption (on average). This is less than in countries with a colder climate and/or lower energy prices, for example, Kyrgyzstan with a heating share in total energy consumption of 60%[5]. Heating in Armenia accounts for about 5 percent of household spending on average, but the poor spend almost twice as much of their household budgets on heating compared with the non-poor – about 6 percent compared to 3 percent. In absolute terms

[4] First reported in Lampietti et al (2001).
[5] See Lampietti/Meyer (2002).

non-poor households declared spending about AMD 16,500-27,500 (USD 30–50) a year on heating, while poor households declared spending about AMD 13,750-22,000 (USD 25–40).

A survey of apartment household residents about their heating practices and preferences was conducted from January through October 2001 in the cities of Yerevan, Charentsavan, Gyumri, and Jermuk. The household survey reveals that poor households with full control of their heating arrangements (that is, without DH) spend considerably less than do households on the DH network where they cannot control the amount of heat used (see Table 1). This suggests that households adapt actual heat consumption and expenditures to their incomes through various strategies: using cheaper fuels, choosing lower temperatures and heating only part of their dwellings.

Table 1 Self-reported indoor temperatures and heating expenditures in Armenia, 2000

Type of household	Reported mean temperature (ºC)	Mean area heated (incl. kitchen, in m2)	Reported mean expenditure (AMD and USD per heating season)	AMD and USD per degree
Poor with DH	15.77	41.21	9900/18	627/1.14
Nonpoor with DH	16.64	41.16	11550 / 21	693/1.26
Poor without DH	14.57	21.88	7150/13	490/0.89
Nonpoor without DH	15.69	27.54	9900/18	633/1.15

Source: Calculations from 2001 household survey data, see Gonzalez/Lampietti (2002).

According to the 2001 survey, household bills for DH averaged AMD 35,000–42,900 a year. Spending on DH, however, was estimated to be considerably less, AMD 22,000–26,000 a year, because many households do not pay their full bills for centralized heating. Table 2 shows the breakdown in annual heat expenditures by poor and non-poor households, respectively, using different heating sources. So although DH *bills* are higher than *expenditures* on other types of heating, DH customers actually pay less than others for their heating needs.

Table 2Estimated Expenditures for Heat (AMD /household/year)

Heating Source	**Non-Poor**	**Poor**
Electricity	26,700 - 35,000	14,500 - 20,700
Wood	21,500 - 28,300	17,600 - 24,100
DH	10,000 - 25,400	3,000 - 21,500

Source: Calculations from 2001 household survey, see Gonzalez/Lampietti (2002)

The survey found the median living space in an apartment to be 41 square meters, which means that the typical household DH bill would be AMD 45,100 a year.[6] The Armenian Energy Commission estimates the actual cost of heating such an apartment at AMD50,000-100,000. So even if consumers paid 100 percent of their bills (and not taking into account any other privileges and discounts), the state is still currently subsidizing at least 30 to 65 percent of the real cost of supplying centralized heating per apartment, depending on location. When non-payments are taken into account, the state subsidy is even larger. For the winter of 2000/01, the estimated cost of DH services for the 247,600 apartments in the four cities was AMD 4,325 million. Households paid an estimated AMD 1,004 million, or just 23 percent of the cost.[7] This means that the

[6] A government decree caps the tariff at 1,100 ARD per m^2 for residential consumers. See section 4.3.

[7] These figures are based on the assumption that about only 38 percent of households received DH across the four cities, and that only 72 percent of those who received DH paid for it, with a mean payment of 13,197 AMD.

government (through the clearance of arrears for fuel, taxes, and other payables or under-maintenance of assets) spent AMD 3,321 million (about USD 6 million) to subsidize the ailing centralized heating system in the four cities.

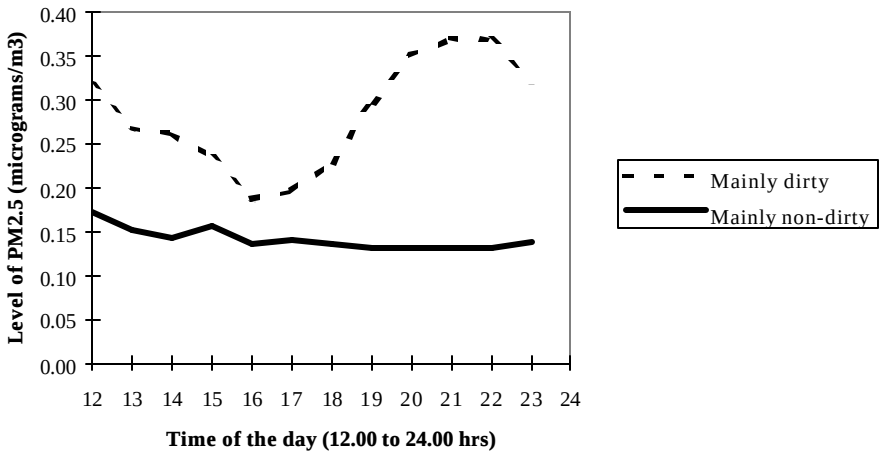
In addition, households in the four cities spent approximately AMD 2,370 million on the other two primary alternative sources of heat, an estimated AMD 806 million on wood as their main heating source and AMD 1,564 million on electricity.[8]

3.2 SOCIAL AND ENVIRONMENTAL COSTS OF HEATING

Not only are poor households heating less, using dirtier fuels and pay relatively more of their income for heating, they also suffer non-monetary costs. These include the health costs associated with not having enough heat and the resulting productivity losses and the health costs associated with burning dirty fuels. In addition, the heavy use of fuelwood leads to environmental costs associated with deforestation, and the opportunity costs of time spent collecting heating material—especially wood.

Apartment households in the four cities consumed approximately 350,000 cubic meters of wood a year to keep warm. This is an estimated 25 percent of the total annual allowable cut in Armenia (see Gonzalez/Lampietti 2002).

Figure 3 Fine particulate matter levels for dirty and clean fuels, by time of day



Source: Based on 2001 household survey data.

As part of the 2001 household survey, air pollution levels were monitored in a number of households. Household members were also asked about the frequency of respiratory illness. Sampled households had an average level of fine particulate matter (2.5 microns or less) of 210 micrograms per cubic meter, which is well above the international standard for safety of 65

[8] Expenditure in alternative heating sources was estimated by multiplying the number of households that use electricity or wood as their main heating source times the minimum estimated amount spent on these heating sources (i.e. 17,600 ARD per household per year for wood and 14,500 ARD per household per year on electricity).

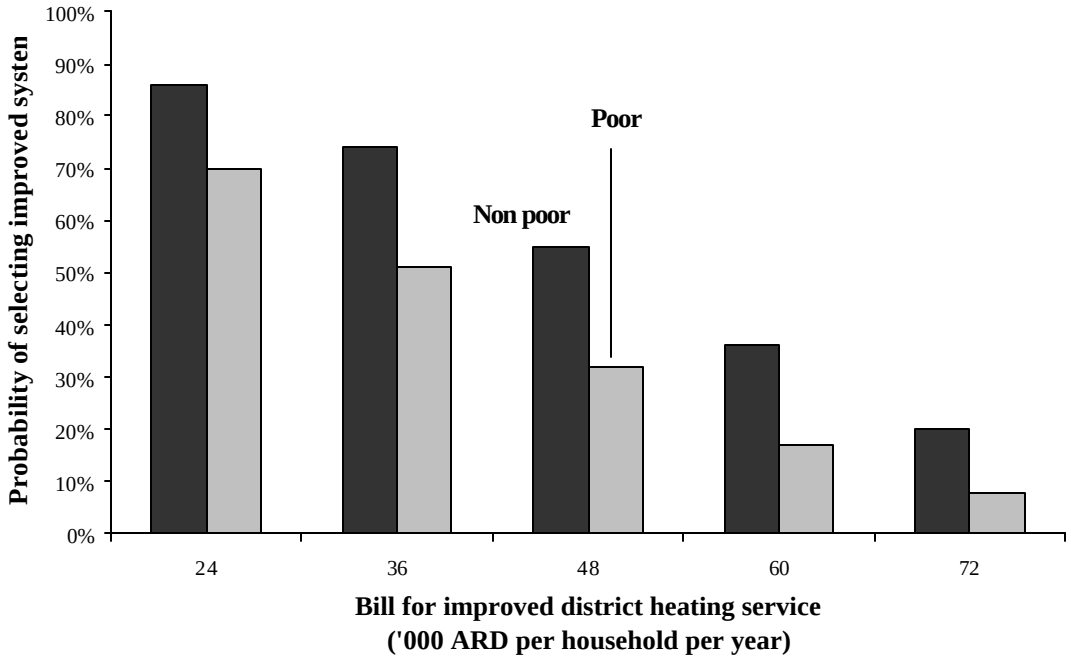
micrograms per cubic meter. Perhaps more important, the peaks of particulate pollution were very high, with an average peak level across the sample of 1,690 micrograms per cubic meter.
There was a clear difference in particulate levels (both average and peak) measured in households using mainly clean fuels and in those using mainly dirty fuels (see Figure 2 for the definition of those fuels). The difference was statistically significant for samples taken between 7 pm and 11 pm, when heating and cooking are most likely to occur; see Figure 3.

Indoor air pollution seems to be related to ill-health, particularly respiratory diseases among women, the very young, the very old, and those already in ill health. The data from the survey suggest that the use of dirtier fuels for cooking and heating greatly increases the incidence of respiratory diseases for those most susceptible to them—the young and the old. The economic costs of this ill-health to women and children under 5 is estimated at 1,723 million ARD (USD 3.2 million) a year (Gonzalez/Lampietti 2002).

3.3 PREFERENCES FOR HEATING OPTIONS AND WILLINGNESS TO PAY FOR HEAT

The household survey revealed, not surprisingly, that the overwhelming majority of households (91 percent) would prefer a reliable centralized heating system as their main source of heating, if cost were no obstacle. Of households that did not receive centralized heating in the winter of 2000/01, 90 percent said they would like a functioning centralized heating service, even though the service would cost more. About 85 percent of poor and non-poor households wanted centralized heating because of its convenience.

Figure 4 Preferences for improved district heating, (percent)



Source: Calculations from 2001 household survey data (Gonzalez/Lampietti (2002)

As part of the survey, households were asked how much they would be willing to pay for an improved DH supply during the entire heating season. The answers ranged between $50 and $100 annually. The improved heating system would have the following characteristics (as indicated in the questionnaire). It would provide enough heat to heat each occupied room in an apartment, to a minimum of 16°C on a reliable 24–hour a day basis, for as many weeks per year as desired by the household; it would be installed at no cost to the household; households could control the amount of heat consumed using controls inside the apartment; bills for the improved service would be based on meter readings of the actual amount of heat consumed, and payments would be spread out over 12 months ("distributed payment option"). The survey results were as follows: 80% of households agreed with annual payments of AMD 24,000 (USD 50), 60% with AMD 36,000 (USD 70) and 40% with AMD 48,000 (USD 100) (see Figure 4). The poor are less likely to chose improved DH, especially at higher prices.

3.4 VIEWS ON COLLECTIVE ACTION

Both the qualitative and the quantitative surveys in 2001 explored views on collective action, for example in the form of a condominium. Some of the key issues emerging from the qualitative survey are presented in Box 2.

Box 2: Collective action – qualitative survey impressions

Collective action by building residents is uncommon in Armenia, and when it does occur, it is usually undertaken in reaction to building maintenance or fee payment issues, rather than as a proactive step. Thus collective action is strongly associated with negative issues rather than positive solutions.

It is normally undertaken only by small groups of people who are directly affected by an issue, such as residents of a floor rather than a whole building. Often, the collective action activities are organized by a representative of the building authority, rather than by the residents themselves.

The absence of collective action is attributed to several factors:

- The traditional "separateness" of Armenian family life (it has few collective elements).
- The belief – dating from the Soviet era – that it is not residents' responsibility to get involved in running the heating system: *"There is a housing-operation office (or condominium or chairman), that collects fees for services, so let them do their responsibilities*."
- A belief – again from the Soviet era – that collective action means that nobody shoulders responsibility.
- The absence of many of the strongest leaders who might initiate collective action—many have gone elsewhere to seek work.
- The perception that collective action involves financial contributions – a serious psychological barrier for many insolvent residents.
- The perception that nonparticipation is a strategy to ensure that heating will continue to be supplied by the state.

Source: ERM 2001

Although the majority of respondents favor collective action in theory, survey results reveal that it is uncommon in practice. The success of collective action may depend on where and how it takes place:

- Residents of Yerevan have the most experience with collective action, through both informal mechanisms and active condominium committees. Experience with such actions positively influences attitudes toward collective action.
- The selection of people responsible for managing collective activities is important. Where collective action has been successful, trust between residents and a tightly knit community structure have existed. To develop such trust among residents, the people responsible for managing collective action must be selected in a transparent and democratic manner. And to

maintain trust, the people responsible for fee collection must be up to the task and their actions must be open to scrutiny by building residents.

- Financial issues are key concerns in the organization of collective action. People do not want the difficult task of managing non-payments or depriving their neighbors of heating. Collective action that focuses on labor contributions rather than financial participation may be more successful, especially in less affluent apartment blocks. If financial participation is required (for example, collection of user fees or repair charges), it will be important to recognize potential implementation problems in buildings with many poor households and great variation in household incomes.
- Successful collective action relies on the abilities of residents to organize such action. In buildings with many empty apartments, there may not be enough residents capable of carrying out these activities.

Survey responses indicate that the current practice of prepayment is regarded as much inferior to a payment option that allows households to spread payments evenly over 12 months, and that a higher percentage of households would prefer individual to collective billing (see Gonzalez/Lampietti 2002). This offers potential solutions for heat service providers to improve cost recovery. The preference for individual bill payment conflicts however with the benefits of collective action at the building or community level to bring down the costs of heat supply (see chapter 5). Groups of households acting together can produce significant economies of scale in consumption, reduce transaction costs in collections, and provide guarantees to service providers. In fact, such collective interface is indispensable for any centralized heating option, since individual connections and disconnections are technically difficult and expensive. Capacity building in working together to solve problems which can pay off in terms of lowering costs is thus necessary to counteract households negative perceptions of collective action.

4. ASSESSMENT OF CURRENT HEAT SUPPLY STRUCTURES

The cities of Yerevan, Charentsavan, Gyumri and Jermuk were chosen for the practical development of heating strategies. The cities lie in different geographical zones of the country, Yerevan having the mildest climate and Gyumri/Jermuk the coldest. Each city was divided into zones according to the dominant mode of heat supply currently employed. In Box 3 the zones/heating options are defined. It should be noted that not all zones are present in all cities. In Table 3 the share of apartment buildings in each of the heat supply zones is listed for each of the four cities.[9]

Box 3: Definition of heating options investigated

CHP (Zone 1): areas with continued supply of heat from CHP plants (only relevant in Yerevan);
Large HOBs (Zone 2): areas with continued supply of heat from large heat-only-boilers (HOBs);
Small HOBs (Zone 3): areas with continued supply from small HOBs;
Reconnection to CH (Zone 4): reconnection of areas that have been disconnected from centralized heating (CH);
No reconnection to CH (Zone 5): areas that have been disconnected from CH, but cannot be reconnected due to deterioration of infrastructure;
'*Block'*: a small building-level boiler providing heat for an autonomous supply scheme with 1-4 buildings attached. *Block 1* is based on a HOB, whereas *Block 2* is based on a small CHP plant; and
Individual (Ind.): individual supply of heat by electricity, natural gas (NG), solid fuels (normally wood), LPG or kerosene. It must be noted that the individual natural gas solution presented is based on the assumption that people will install 3-4 gas stoves per flat (this to be able to compare with CH). However, many people will opt for 1 or 2 stoves per flat making the individual natural gas option more competitive than shown in the tables below.

4.1 STATUS QUO OF CENTRALIZED HEAT SUPPLY IN THE FOUR CITIES

Heat supply in Yerevan

Before 1991 most of Yerevan was heated by centralized heating, either in the form of large heat networks connected to the CHP plant or one of several large HOBs or in the form of smaller networks where typically 10-20 buildings would be connected to a small or medium-size HOB. Today only limited parts of the larger networks are still in operation (six out of eight large HOBs still supply part of their original area), and a mere four out of the more than 200 smaller networks are still functioning. A total of 1033 apartment blocks are connected to centralized heating today compared to around 4500 in 1991.

About 25% of the multi-story buildings in Yerevan are heated partly or fully by centralized heating (Zones 1,2,3; see Table 3). A little more than one fifth of the buildings (mostly in central Yerevan) can no longer be connected to centralized heating because the boiler house and/or distribution pipes have deteriorated and the internal piping in the buildings has been wholly or partly dismantled. The division between Zone 4 and Zone 5 has been difficult because very little

[9] If not otherwise mentioned, the information in Chapter 4 is based on COWI 2001.

hard data exist on the condition of the DH distribution pipes and the internal piping in the buildings in the different parts of town.

The heat is supplied by two public companies, Yerevan CHP Company (under the Ministry of Energy) and Yerevan Heating Company (under Yerevan Municipality). The CHP plant has very old equipment and is basically only kept in operation to supply steam to a large industrial plant nearby. At present Armenia has a surplus of electric power from a nuclear power plant and a relatively modern thermal power plant.

Table 3: Share of apartment buildings in the different heat supply zones, 2001 (in percent)

	Yerevan	Charentsavan	Gyumri	Jermuk
Zone 1 – CHP	2%	0%	0%	0%
Zone 2 – large HOB	22%	0%	45%	64%
Zone 3 – small HOB	1%	16%	0%	34%
Zone 4 – Reconnection to CH	53%	84%	1%	2%
Zone 5 – No Reconnection	22%	0%	54%	0%

Heat supply in Charentsavan

Until 1991 all apartment buildings in Charentsavan were connected to centralized heating, supplied by a central boiler house with 5 substations and 4 small capacity boilers. The central boiler supplied heat to 163 buildings (out of which 135 are residential), but this supply stopped in 1992 due to lack of fuel. In 1996 it was re-started but not to the full extent.

During the 1998-1999 heating season heat was supplied to 118 buildings. However, due to a very low collection rate of heat payments, the centralized heat supply was closed down totally during the 1999-2000 heating season. During the 2000-2001 heating season 30 buildings were supplied with heat, but only for a mere 60 days.

In 1997 an individual boiler house with capacity of 500kW for one building with communal apartments was constructed within the framework of the TACIS program. It is equipped with high-efficiency boilers from the UK (thus the nickname “English Boiler House”). The residents of the communal apartment did not pay their heating fees and therefore the boiler house could not be operated as planned. In 2000 a locally manufactured boiler of the brand Ar-Ar (see picture on the title page) was established in Charentsavan as an autonomous system connected to two buildings. It supplied heat for a small part of the 2000-2001 heating season, but is expected to operate again in 2001-2002.

Table 3 shows that at present only a very small part (16%) of the apartment buildings in Charentsavan are heated partly or fully by centralized heating (Zone 3). The remaining apartment blocks are considered to be in Zone 4, i.e. they could technically be reconnected to some sort of centralized heating.

Heat supply in Gyumri

Until the devastating earthquake of 1988, heating in Gyumri was supplied from 63 small-scale boiler houses with a total heat production capacity 240 Gcal/h. 751 multi-story buildings and 157 public buildings were connected to the system.

After the earthquake, a large HOB was built in an industrial area, three kilometers from the residential Ani district which it supplies today. This HOB is owned by ARMGASPROM which sells heat to the municipal heating company. Besides distributing and selling heat from the large HOB this company has 24 small-scale boiler houses on its balance (10 of them were built after 1990) with a total capacity of 77.2 Gcal/h. However, none of these are operating due to a number of reasons – the main one being that the equipment has deteriorated.

Table 3 shows that 45% of the multi-story buildings in Gyumri are heated partly or fully by centralized heating (Zone 2). A little more than half of the buildings can no longer be connected to centralized heating because the boiler house and/or distribution pipes have deteriorated and the internal piping in the buildings has been wholly or partly dismantled.

Heat supply in Jermuk

In Jermuk all apartment buildings are connected to operational centralized heating facilities (see Table 3). One boiler house supplies heat to 17 residential buildings, 4 administrative buildings (town administration, police headquarter, school and Art school). Before 1990 the boiler house also supplied heat to 9 sanatoriums and hotels. Another boiler supplies heat to 32 residential buildings (1335 apartments including 287 unoccupied). Earlier three more boiler houses supplied heat to different non-residential buildings. However, with the decline of Jermuk's tourist industry these three boilers have been closed. Two buildings in Zone 4 have never actually been connected to the network since they were constructed after 1991.

4.2 TECHNICAL ASSESSMENT OF THE CENTRALIZED HEATING INFRASTRUCTURE

The quality of centralized heat supply is poor in all four cities. With few exceptions, the boilers and distribution networks are under-performing because of insufficient maintenance and repair. In many places the supply is erratic, and in all four cities the supply period is shorter than based on norms (see Table 9 for Yerevan). Customers complain that they get less heat than they are billed for.[10]

All the operating boilers are gas-fired and their conversion efficiencies are estimated to range between 60% and 90% (the high end only applies to the two new autonomous system boiler houses in Charentsavan). This can be compared with state-of-the-art gas boilers used in western Europe that have efficiencies just around 100% (with efficiency measured against the lower calorific value of natural gas).

The distribution systems are quite old by now, and many pipes have been in operation beyond their originally estimated lifetime of 25 years. It is difficult to make an exact assessment of the state they are in (e.g. dryness of insulation, or its mere existence, tightness of fittings, leakages). Anecdotal evidence indicates that the systems are quite poor, but it has been impossible for the consultant team to make any measurements since the project started during summer. Analysis of operational records also offers little information on the transmission/ distribution efficiencies of the networks since there is little metering. Water losses are huge, but inferring efficiency from the losses is a misleading indicator due to the extensive illegal tapping of hot water (see below).

[10] Preliminary evidence from a metering pilot project in Gyumri (financed jointly by the PHRD grant and UNDP/GEF) shows that in February 2002 the central heat supply temperature was only 46°C and that actual heat consumption was only about 70% of the contracted amount, even taking into account illegally tapped hot water.

The quality of all those distribution pipes that are not currently in operation is also uncertain. In many cases these pipes will be so corroded by now that it would not be possible to reconnect them to the system. Those sections that have been out of use since the early 1990s must most likely all be considered to be beyond repair.

The internal piping installations are in general of poor quality, frequently dismantled where centralized heating is not supplied anymore. The Demand Analysis Report (ERM 2001) mentions complaints of greatly varying temperatures across and within buildings which is partly due to improper balancing of the system and lack of balancing valves in buildings.

The DH companies supply only heat and no hot tap water (HTW). There is, however, a widespread use of radiator water, for HTW purposes and/or because the municipal cold water supply is poor. Many people have simply installed a tap on the radiator from which hot water can be taken out. According to the household survey, there is a high demand for HTW and the practice of moderate water theft is generally condoned. Since water flow is not metered, this practice goes unaccounted and largely unpaid and unpunished.

In chapter 5, the estimates of the short-term costs of supplying heat from centralized heating are reported (see tables 4-7), assuming that no investments are made.

4.3 INSTITUTIONAL ISSUES FOR CENTRALIZED HEATING

Ownership and regulation. Centralized heat supply is under public ownership and is presently managed by municipal companies in the four cities. There are a few exceptions where heat generation plants are controlled by the Ministry of Energy, and some of the responsibility for managing the transmission/distribution of heat and collections has been divested to those plants, e.g., in the case of the Yerevan CHP plant. Centralized heating is regulated by the Energy Commission, in charge of technical and commercial licensing and of tariff setting.

The *DH tariffs* calculated by the Energy Commission for each of the eight municipalities currently supplied are supposed to cover all operating and maintenance costs but with no room for depreciation. For the 2000/2001 heating season they were (per m² per heating season; Source: ERM 2001):

- Yerevan: 1450 AMD (2.6 USD)
- Gyumri: 2628 AMD (4.8 USD)
- Charentsavan 1203 AMD (2.2 USD)
- Jermuk 1679 AMD (3.0 USD).

A government decree has limited the consumer payment to 1100 AMD per m² per heating season with the difference to be paid by municipalities and the government.

The financial situation of the DH companies – government subsidies. The municipal DH companies are unable to collect more than about 30% of the amounts that they bill customers, the only exception being the Yerevan CHP plant. This has led to their insolvency and inability to pay for the natural gas supplied to them by ARMRUSGASPROM. The gas company ends up with a large accumulated debt that in the end is covered by the government. This represents a much larger subsidy element than the direct subsidy resulting from the difference between cost of supply and maximum tariff. The total degree of subsidization thus ends up in the range of 70-90% of the total cost of supply - only benefiting the minority of the population supplied with

centralized heat and not the majority who have to manage with individual solutions. See also the estimates based on the household survey data in chapter 3.1.

Despite their desperate financial position the municipal heating companies are keep on supplying heat, though with ever deteriorating equipment, at reduced service levels, increasing consumer dissatisfaction, and ultimately even lower collection rates. Everybody recognizes that this is vicious cycle, but the practice is continuing, probably due to political pressure:

- for "social reasons", quoting the health problems of children and the elderly in the poorest part of the population who cannot afford the individual solutions. However, it should be noted that according to the household survey (ERM 2001) a slightly larger share of the non-poor (14%) are connected than the poor (11%);
- because many people still think that the state has an obligation to supply cheap centralized heat like in the Soviet times; and
- because many experts argue that "rationally" centralized heating is the optimal supply option so an effort should be made to keep it going.

At the same time the heating companies still operate pretty much like they used to do before independence. The organizational structure is still very hierarchical, there is little forward planning, and there is no concept of being a service provider who has to keep his part of the contract – i.e. to provide the promised quantities at the promised quality at the promised time.

Customer relations. The heat supply companies normally have individual contracts with each household in a building connected to the centralized heating network. The customers are not metered and therefore billed based on m² of living space. Non-payment for heat has been rampant (see above), and in the past few years pre-payments schemes were introduced. In order to receive supply, at least 60% of residents in a building have to sign up and pay at least 30% of the annual fee as a deposit. The shares vary from company to company.

With this scheme collections have improved some, but are still quite low. Heat suppliers have found it difficult to collect the remaining installments. According to the household survey (ERM 2001) the collection rate in Yerevan was 24.4% in 2000-2001 (this was the status in August 2001), a slight improvement from the year before when the rate was 19.5%. In Charentsavan the collection rate was under 3% in 1999-2000, and in Jermuk only 7% of fees from residential consumers had been paid in by end of January 2001. Comparing these numbers to collection rates from previous years may be somewhat misleading, since many households reduce their arrears by paying after the end of the heating season. Sanctions for non-payment are almost impossible since a whole building or a block of buildings would have to be cut off collectively, which would be illegal under the Armenian Civil Code. In principle the DH company could take a non-payer to court, but this may take a long time and not be an effective remedy..

There are many reasons quoted for the low collection rates. Among the most important are:

- Insolvency of the residents
- the inability to sanction non-payments
- the large number of locked/abandoned apartments where households are permanently or temporarily absent (15-30% of apartments)
- general dissatisfaction with the quality of the service (interruptions, low indoor temperature, unbalanced supply)
- dissatisfaction with the requirement to make a large (30%) down-payment
- people still tend to see heat as a commodity the government should supply at very low cost like in the Soviet times (i.e. heavily subsidized)

- fee collectors strike deals with residents on a reduced amount
- inability to meter actual consumption.

Besides centralized heating, there have been a few attempts to establish *autonomous heating systems* around block-level boilers. Examples are the "English boiler" and the Ar-Ar boiler in Charentsavan. But these have either been unsuccessful due to institutional problems or have only just started. Since there are only very few examples of autonomous systems, no separate regulation is currently in place for these systems.

4.4 NATURAL GAS SUPPLY INFRASTRUCTURE

Before 1991, Armenia had the highest gasification rate (83%) in the FSU. 45% of the gas distribution system in Armenia has been rehabilitated and 20% of customers re-connected as of 2000. In the residential sector, only one-family houses have been reconnected, but not yet any of the multi-residential buildings.

Gas in Yerevan is delivered in a three-tier scheme: gas regulating central stations (GRCS) receive high pressure gas from Gas Distribution Stations (GDS) and send middle pressure (MP) gas to consumers and Gas Regulating Points (GRP). The latter reduce the pressure for transport to the end-users. In the other cities there is no high pressure network. The use of gas in the multi-residential building market was limited to cooking, and, for safety reasons, to buildings with fewer than 12 floors.[11] Steel was the leading material and, because gas was meant to be used mainly for cooking, the capacity of the low-pressure (LP) networks was sufficient. With an expanding market and for safety reasons, modern design and operation technologies need to be introduced that will enhance overall gas distribution safety, decrease the cost of both the construction and operation of gas networks, and increase the capacity. Both objectives could be achieved by substituting MP for LP and polyethylene (PE) for steel through the tubing of old LP pipes, as well as network extensions.[12] Steel pipe corrosion is the cause of breakdowns that affect the gas distribution networks, threatening the life of people and gas workers and disrupting supply to consumers. Corrosion is generally caused by stray electric currents that pierce the pipe coating and remove particles of metal in a process that takes place over several years. Gas distribution networks suffer from both a lack of comprehensive pipe protection and the poor efficiency of locally made protection devices, where installed. Another constraint lies in most current regulations, which often prohibit the use of MP within 4 meters of a building; this prevents the MP network—including service lines—from being laid under most sidewalks and reaching the building wall where the building regulator should be installed. Such regulations, once established for safety reasons, have proved unwarranted in any country in which MP is in use.

4.5 INDIVIDUAL HEATING

In average for the four cities more than two out of every three apartment buildings that used to be supplied with centralized heat before 1990 have been disconnected and now rely on individual heating options.

[11] The use of gas water heaters and heating boilers was restricted to buildings with up to 5 floors.
[12] For details see ESMAP 2000.

The most typical individual heat source are stoves where firewood can be burnt together with other solid combustibles, such as inflammable domestic waste combined with electric panel heaters - such heaters are quite cheap and sometimes home-made. Electricity can also be used in other ways, e.g. by way of immersion heating connected to radiators. However, since the use of electric heaters is expensive, this is rarely the only source of heating, except in the more affluent households. Central gas is currently used for individual heating only in a few one-family homes. This is due to the slow reconnection of customers requires, metering, and the perceived safety problems of gas supply in multi-apartment buildings.[13]

The individual options are in many ways superior to centralized heat supply which in its current state is impossible to meter, regulate or turn off, since they are flexible and allow households to

- use a combination of fuels (typically electricity and wood);
- heat less space than the "useful area" normally used to calculate an apartment's heat demand (this is the case especially among the poor);[14]
- heat for a shorter or longer period than the "heating season" established for centralized heating systems; and
- use heating selectively and according to the household cash-flow situation.

4.6 CONDOMINIUM ISSUES

Apartments in multi-apartment buildings have been privatized in Armenia in the same way as in many former Soviet countries. About 20% of apartments are rented out or empty with the owners living abroad, mainly in Russia. Earlier the utility services to most of the buildings with privatized apartments were administered and maintained by municipal housing maintenance companies, successors of the Soviet time ZHEKs (municipal administration and maintenance companies). These were not successful in collecting fees and in providing services to the buildings. Condominiums and other forms or collective organization of apartment owners have been promoted instead.

A large number of condominiums have been established; by early 2001 there was a total of 602 condominiums in Armenia, representing 4,000 buildings and 182,000 apartments. Most of them are in Yerevan, where around 40% of the apartment buildings are now organized as condominiums,[15] but very few exist in the other three cities. However, less than 50% of existing condominiums are active, and even fewer are involved in the heat supply as an interface between the DH companies and the individual consumers[16].

A legal framework for condominiums exists, but is still somewhat deficient. Amendments are currently discussed in parliament. More generally, condominiums are largely still ineffective for the following reasons (see also Box 2 in chapter 3):

- Heat supply contracts must be drawn up between heating utility and the individual apartment owners, not the building association/condominium;

[13] Installation of gas appliances requires separate smoke flues, and a room volume of at least 7.5 m3.
[14] With CH, a household currently is forced to heat (and pay for) the entire living area even if he would prefer to heat (and pay) less. There are now a few cases however, where consumers have been allowed to pay for less m^2 after disconnecting some of their radiators.
[15] See ERM 2001.
[16] ERM 2001 reports of one case in the Davitashen district in Yerevan, where the DH company has made a heat supply contract with the condominium.

- Condominiums often consist of a large number of buildings, at times involving thousands of apartments;
- It is virtually impossible to enforce payments of condominium fees;
- Condominiums have no access to financing and are thus unable to borrow for building improvements;
- The condominiums are not linked to support schemes that can help the poorest families participate in collective activities, such as investments in heat supply or building improvements.

4.7 CONCLUSIONS: SPECIFIC CHALLENGES FOR IMPROVING HEATING IN COLD TRANSITION COUNTRIES

Providing access to heating to the Armenian urban population is encountering problems on many levels.

- Income levels of households within the same apartment buildings can diverge widely, making the identification of and agreement on joint solutions difficult. This problem is aggravated by the large number or absentee owners which is widespread in Armenia, unlike in any other country of the FSU. A flexible housing market which would go a long way in resolving the income divergence and absentee problems is slow in materializing.

- The transfer of building ownership from municipalities/government to apartment residents has left a vacuum with nobody being responsible or able to maintain buildings, especially the common spaces, and organizing the provision of communal services effectively. The legal framework is fairly advanced after recent amendments, but it is still not adequate for efficient operations of those community associations taking over responsibilities. Contracts for typical communal services such as heating, water supply, garbage removal are still concluded with the individual household, rather than more effectively with an association of homeowners.

- Not only the heat supply infrastructure, but also the building infrastructure is deteriorating. Buildings are badly insulated and therefore require a large heat input for even a minimal comfort. Centralized heating systems are misused by almost all consumers who bleed hot water from radiators because of poor municipal water service and because it is an easy if illegal source for hot tap water. The potentially clean, efficient and not too expensive alternative of natural gas heating is hampered by the discontinuation of gas supply to apartment buildings because of unsafe physical condition of the existing gas infrastructure and the poor creditworthiness of customers who lack funds for investing in alternative supply options.

- The existing heat service providers are inflexible, bankrupt municipal heating companies which mostly lack a commercial attitude. Alternatives, for example small private businesses, have been very slow to emerge since there is little experience with alternative heating options, all heat supply currently is regulated heavily by the Energy Commission, access to financing is non-existing, potential customers present a big risk both in terms of diversity and payment attitudes, the time horizon necessary to recoup investments is considerably longer than contract periods that customers can reasonably be expected to sign up for, etc.

The baseline conditions under which the development of the UHS took place are summarized in

Box 4. They pose powerful constraints in identifying solutions to providing improved access to sustainable heat supply.

Box 4: Baseline Conditions for the Urban Heating Strategy

- Heat demand is constrained by low household incomes;
- Low incomes are aggravated by the absence of effective customer organizations that would be able to contract for communal services,
- Significant gaps in market information about available options, their costs and benefits;
- For all heating options, heat prices and service standards are regulated tightly; safety and environmental standards, however, are either absent or lack enforcement;
- Commercial heat supply is constrained by high risk of supplying Armenian customers who have a history of non-payments for basic services and are perceived as high credit risks, and by the lack of financing on affordable terms.

5. ASSESSMENT OF HEAT SUPPLY OPTIONS: TECHNICAL, FINANCIAL AND AFFORDABILITY ISSUES

5.1 TECHNICAL AND COST COMPARISON

The analysis of heating options was done in two steps. In a *short/medium-term analysis*, covering 5 years, the objective was first to assess the existing heat supply structure, covering technical, financial, fiscal and institutional aspects (see chapter 4); in a second step it was investigated whether heating options would be able to deliver heat sustainably according to the affordability constraints without incurring any but minor investments.

For the *long-term analysis* the costs of heating were determined for all heat supply options, including those investments ensuring that the equipment would be functional for at least 20 years. Two different demand levels were investigated, normative heat demand and reduced heat demand.

The scenario with *normative heat demand* uses the Armenian (Soviet) SNIP norms for heat consumption in each type of standard building including the consumption of 50 liter per person per day hot tap water (HTW), recognizing that people currently tap water illegally from the radiators for HTW purposes. The scenario with *reduced heat demand* is copying the way heat is being consumed in households with individual heating (electricity and wood/solid fuels), i.e. people are heating a small part of the flat and most of the flat has a temperature much lower than the "normative" comfort temperature (20°C). The normative space heating demand is reduced by 50% and the HTW demand is totally eliminated. The total reduction is around 60% of the normative heat demand.

Table 4 Comparative Cost of Heat in Yerevan (in USD)

Yerevan	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	USD/MWh	USD/m²/year	USD/MWh	USD/m²/year	USD/MWh	USD/m²/year
Zone 1=CHP	31.26	3.51	31.47	3.54	61.22	2.93
Zone 2=large HOB	18.78	2.19	25.94	3.02	45.36	2.29
Zone 3=small HOB	**18.09**	**2.07**	33.31	3.80	62.95	3.08
Zone 4= Reconnection to CH	26.37	2.97	25.43	2.86	45.04	2.17
Block 1 – HOB	21.58	2.42	**19.14**	**2.15**	**31.62**	**1.54**
Block 2 – CHP	45.68	5.13	36.80	4.14	85.14	4.14
Individual electricity	51.94	5.83	50.29	5.65	56.62	2.75
Individual NG	29.35	3.30	24.96	2.80	41.80	2.03
Individual solid fuels	28.13	3.16	27.27	3.06	37.77	1.84
Individual LPG	57.55	6.46	55.83	6.27	61.69	3.00
Individual kerosene	61.22	6.87	59.82	6.72	64.53	3.13

Table 5 Comparative Cost of Heat in Charentsavan (in USD)

Charentsavan	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	USD/MWh	USD/m²/year	USD/MWh	USD/m²/year	USD/MWH	USD/m²/year
Zone 3=small HOB	**17.37**	**2.53**	25.65	3.73	45.83	2.93
Zone 4= Reconnection to CH	21.62	2.95	35.04	4.81	67.19	4.02
Block 1 - HOB	20.68	2.86	**18.38**	**2.54**	**29.64**	**1.79**
Block 2 - CHP	42.81	5.91	34.53	4.78	79.03	4.78
Individual electricity	50.90	7.03	49.50	6.85	54.71	3.31
Individual NG	26.58	3.67	22.88	3.17	36.76	2.22
Individual solid fuels	26.69	3.69	25.97	3.59	34.64	2.09
Individual LPG	56.55	7.81	55.11	7.63	59.93	3.63
Individual kerosene	60.43	8.34	59.28	8.21	63.13	3.82

Tables 4-7 contain the detailed results for all four cities for the short-term analysis and the long-term analysis.[17] The heating option with the lowest costs are presented in boldface. The following conclusions can be drawn:

- In the short term centralized heating is least-cost in many areas due to the fact that it utilizes equipment and plant that is already written off. There is however a considerable uncertainty about the condition of the networks which may require more maintenance than anticipated and about the commercial sustainability of centralized heating.
- The effect of the reduced demand is that costs per physical unit almost double, whereas costs per m² of living area are reduced by 20-40%.
- The least-cost solution in the long term is an autonomous system with a small heat-only boiler supplying a small number of buildings (called Block 1 in the tables). This is the case both for normative and reduced demand. However, an individual natural gas option with a reduced number of gas stoves per apartment would in many cases be cheaper and would probably (even though it does not give quite the same comfort as district heating) in many areas be a very competitive solution, provided the safety aspects can be dealt with satisfactorily.

[17] Tables 4a-7a in the annex contain the results in AMD. Please note that the short-term and the long-term analysis results should not be directly compared, since they use slightly different calculation methods and area delimitations (see COWI 2002). In the following, the information in Chapter 5 is based on COWI 2002, if not otherwise noted. The assumptions underlying the analysis are documented in Annex H of that consultant report.

Table 6 Comparative Cost of Heat in Gyumri (in USD)

Gyumri	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	USD/MWh	USD/m²/year	USD/MWh	USD/m²/year	USD/MWH	USD/m²/year
Zone 2=large HOB	19.24	3.85	19.42	3.88	27.95	2.50
Zone 4= Reconnection to CH	22.16	4.43	26.94	4.84	44.93	3.64
Block 1 - HOB	**19.24**	**3.67**	**17.19**	**3.28**	**26.65**	**2.26**
Block 2 - CHP	38.24	7.28	31.12	5.93	69.96	5.93
Individual electricity	49.42	9.41	48.38	9.22	52.09	4.41
Individual NG	22.63	4.31	19.96	3.80	29.71	2.52
Individual solid fuels	24.64	4.70	24.14	4.60	30.25	2.56
Individual LPG	55.14	10.50	54.06	10.30	57.48	4.87
Individual kerosene	59.28	11.30	58.45	11.14	61.15	5.18

Table 7 Comparative Cost of Heat in Jermuk (in USD)

Jermuk	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	USD/MWh	USD/m²/year	USD/MWh	USD/m²/year	USD/MWH	USD/m²/year
Zone 2=large HOB	**18.35**	**3.02**	23.17	3.82	40.40	2.91
Zone 3=small HOB	20.72	3.28	35.04	5.54	67.95	4.66
Zone 4= Reconnection to CH	24.14	4.42	**16.40**	3.01	**24.68**	2.00
Block 1 – HOB	19.06	3.13	17.12	**2.81**	26.76	**1.91**
Block 2 – CHP	37.73	6.19	30.76	5.04	70.54	5.04
Individual electricity	50.04	8.21	48.88	8.02	53.31	3.81
Individual NG	24.32	3.99	21.22	3.48	32.99	2.36
Individual solid fuels	25.54	4.19	24.93	4.09	32.27	2.31
Individual LPG	55.76	9.14	54.53	8.94	58.63	4.19
Individual kerosene	59.78	9.80	58.81	9.64	62.09	4.44

- In the reduced demand case, the financial cost of small block boiler heat systems (Block 1) is comparable with solid fuel (wood) stoves. However, with an almost identical cost households would probably prefer the centralized heating option for its convenience and the avoidance of wood cutting.[18] However, households would need access to affordable financing to cover higher up-front costs of a centralized heating solution.
- Small CHP is not cost-effective at present but it may become more financially attractive when electricity demand begins to exceed available generation capacity and competitive import.
- In some cities the reconnection to centralized heating of currently non-supplied areas (Zone 4) appears to be the cheapest option. This however is due to the marginal nature of the investments that often benefit from plant investments that have been made in other zones (1-3). The low value is therefore misleading insofar as investments in Zone 4 would not make sense on a stand-alone basis.

[18] The calculations assume a standard wood stove purchased at low price and with poor efficiency. The result would be slightly different if comparison was made with more expensive improved wood stoves with higher efficiency.

The obvious overall conclusion of these calculations could be that all large centralized heating systems should be abolished and autonomous systems promoted instead. However, it would not be financially beneficial or practically possible to reorganize all existing centralized heating to autonomous systems at the same time as promoting them in zones where the DH is no longer operational (Zones 4 and 5). Further-more, the average values for the Zones often hide variations in financial viability between more or less densely populated areas.[19]

From the purely technical/financial cost point of view the following approach seems preferable:

- In the short term centralized heating in zones 1-3 should be maintained to the extent that customers are able to organize themselves in a manner which eliminates payment risk, enter into a heat purchase contract which allows service providers to cover supply costs (with any subsidy from the municipality provided in a transparent manner)[20] - a business plan must prove that.
- In the longer term centralized heat supply should only be maintained in the most financially viable supply areas and within a commercial contractual framework. Centralized heating in other areas should be discontinued.
- Centralized heating in zone 4 should not be resumed in the short term (except in the rare case where a very viable reconnection can be made for a very low cost). Instead autonomous systems should be promoted.
- Autonomous systems should also be promoted in zone 5 and those parts of zones 1-3 to be disconnected from centralized heating.
- If a new medium-size CHP plant is built in Yerevan, heat from this plant could be the cheapest solutions for the areas adjacent to the plant. However, this will only be case if demand for electricity (price and quantity) permits pricing the heat produced as a waste product.

Basing the heat strategy recommendations purely on technical and financial considerations would, however, neglect to take into account the serious constraints stemming from low affordability and information and institutional barriers. Affordability is investigated in section 5.3, while a framework to reduce institutional barriers is proposed in chapter 6.

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[19] The calculations in Tables 4-7 were made assuming that the gas price and electricity tariffs would remain at their current levels. The separate report on the gas sector (Yerevan Project 2002) forecasts, however, that the gas import gas price of currently USD/TCM 53 is likely to gradually increase to the world market price level, reaching USD/TCM 75 in 2013 and 83 in 2020 (Scenario "medium"). This would lead to an increase of the residential consumer tariff from currently USD/TCM 87.9 to USD/TCM 90 in 2003 (taking into account the gas infrastructure investment costs as per Table 8) to about USD/TCM 120 by 2023. The increase to the world market price level would obviously affect the cost level of all gas-based heating alternatives – i.e. central heating, block heating and individual NG. The gradually higher gas price will need to be added to the balance costs of gas-based heating options presented here. The effect will be very slight during the first 5 years (only a 5-10% increase on the calculated balance cost), but after this period the competitiveness vis-à-vis wood stoves would be significantly affected by the rising gas prices if wood fuel prices remained stable. However, as forest resources are being depleted and/or restrictions will be enforced, it is conceivable that also the price of wood fuel will increase. The impact of a higher electricity tariff has not been investigated. A higher electricity tariff would have a favorable effect on a CHP-based heat supply option.

[20] Necessary if supplier is state-owned.

5.2 IMPACT OF REQUIRED GAS NETWORK REHABILITATION AND EXTENSION INVESTMENTS[21]

Independent of the heating option, some parts of the existing gas distribution networks have to be rehabilitated, using the techniques mentioned in section 4.4. In multi-apartment buildings, the existing intra-building gas pipes are frequently in need of repair or even reconstruction, including installation of gas-regulating devices and gas meters. Current standards require that new pipes are to be placed on the outside of the apartments. This is more flexible and cheaper (empty apartments, unknown condition of existing interior pipes) and provides the gas company with easier access to reading each gas meter.

The investments in the gas infrastructure necessary to accommodate the different heating options can be divided into three broad categories:

- Option I Rehabilitation of the existing centralized heat supply system (*Zones* 1-4). Heat and hot water supply to multi-apartment buildings is from centralized heating systems, and cooking is with gas. Gas supply is by low pressure network.
- Option II Construction of *block* boiler-houses for 1-3 buildings. Apartments get gas only for cooking, and heat and hot water demand is met from small-capacity boiler-houses for 1-3 buildings. Gas distribution network is planned for medium-pressure. Residents get low-pressure gas after gas pressure regulation by GRPs installed in the boiler houses.
- Option III *Individual* gas heating of apartments (and individual houses). Cooking, heat and hot water demands are met by gas stoves, heaters and water heaters installed in apartments/houses, medium pressure gas is brought up to the buildings entrances. Gas regulating points are installed in the entrances, which provide apartments with low pressure gas.

However, it should be considered whether it is worth the cost of reconstructing the intra-building network and supplying an individual gas meter in options I and II if only a small amount of gas for cooking has to be delivered to each apartment. This option should be compared against the use of liquified petroleum gas (LPG or bottled gas) and the already extensive use of electric stoves for cooking.

The investment costs of the different options for the four cities are summarized in Table 8. Irrespective of the heating option, the investments in the gas infrastructure (including intra-building networks and individual gas meters, but excluding appliances) are expected to fall into a relatively narrow range between USD 37 and 41 million. About two-thirds of this is, however, for intra-building networks, leaving USD 8-10 million for rehabilitation and modernization investments of the high and medium pressure and the intra-district networks in the four cities.

[21] Based on Yerevan Project 2002.

Table 8: Total Rehabilitation Cost of Natural Gas Infrastructure in 4 Cities

	Yerevan		Gyumri		Charentsavan		Jermuk	
	Million USD	USD/ apart.	Million USD	USD/ apart.	Million USD	USD/ apart.	Million USD	USD/ apart.
HP+MP	2.81	15	0.71	29	0.18	35	0.028	26
Intra-district								
Option I = Zones 1-4	3.31	18	0.92	38	0.12	23	0.015	14
Option II = Block	5.05	27	1.25	52	0.19	36	0.020	19
Option III = Individual	4.55	24	1.24	51	0.17	32	0.165	15
Intra-building (first number for multi-apartment buildings, second number for individual houses)								
Option I,II	21.56 / 4.25	142 / 121	0.59 / 1.31	134 / 115	0.71 / 0	134 / 0	0.047 / 0	134 / 0
Option III	25.06 / 4.25	165 / 121	0.70 / 1.31	157 / 115	0.83 / 0	157 / 0	0.072 / 0	66 / 0
TOTAL Cost								
Option I	31.94		3.54		1.02		0.091	
Option II	33.67		3.87		1.09		0.095	
Option III	36.67		3.96		1.19		0.116	

5.3 IMPLICATIONS FOR AFFORDABLE HEATING SOLUTIONS

The average apartment size in Armenia is around 60 m^2. Based on the cost data in the above tables, the annual heat bill would be around 90,000 AMD (assuming normative heat demand) and around 60,000 AMD (assuming reduced heat demand). From the affordability analysis (see chapter 3), it appears that very few people (probably less than 10%) would be able to pay for the normative heat supply and that only around 30% would be able to afford even the reduced supply solution.

The implications of this finding are significant:

- It will be difficult for any heat supplier to find buildings with enough customers to buy even the most reduced supply option.
- It will be difficult to motivate condominiums to actively intermediate a collective approach to solving the heating problems of apartment occupants.
- In the short term the "cheap" existing supply options adopting a minimum investment strategy and providing heat according to the reduced demand option will have the best chances of providing heat without requiring subsidies. However, this is not a long-term solution since existing solutions may be financially cheap but have a rising economic cost. Furthermore, any public or condominium infrastructure used to supply heat will continue to deteriorate without additional investments.
- Electricity and wood stoves with low capital costs and the possibilities of adjusting consumption to affordable comfort levels will continue to play a big role in the overall heat supply picture of the country – at least in the short and medium term. However, as mentioned above, even these options will be constrained by affordability as prices approach their economic cost levels.

This leads to the following approach to ensure affordability in the heat strategy:

- The strategy should consist of a first phase during which the framework for a market-based provision of heating services is put in place, including testing whether consumers opt for existing centralized heat supply under conditions which permit full commercialization of centralized heating services (*survival*) and whether private providers of autonomous heating services emerge. This phase is followed by a period where the surviving centralized heating systems coexist with new heating options (*recovery*), before a period of larger, private investment to generate major improvement in service quality and coverage (*growth*).
- If centralized heating is to be continued at all, modifications will have to be made in the way it is supplied to consumers in order to provide affordable quantities and quality of heat without continuing widespread subsidies; i.e., the provision of heat has to be controlled by the consumer, it has to be flexible and it has to be billed based on metered consumption.
- Decentralized heating (autonomous systems) and individual natural gas stoves should be promoted in all areas and allowed to compete with centralized heat supply options under a sensible institutional framework[22]. The high initial costs associated with these options may, however, render them unaffordable for the majority of the population until economic growth improves the general purchasing power.
- Recognizing that many households may be unable in the short/medium term to participate in collective, condominium-based arrangements or afford clean individual heating options, the government may wish to consider reducing barriers for the development and marketing of efficient wood stoves which are better designed for use in multi-apartment dwellings than the existing stoves. However, the environmental implications of continued wood burning would need to be carefully assessed.
- Low-cost insulation of buildings should be encouraged by systematically eliminating informational, institutional, financing and affordability barriers. There are many measures such as (re-)installation of windows and doors in the staircases, tightening of window frames, etc. that are very low-cost and/or have a short pay-back time that could partially be done by residents themselves. However, functioning condominiums may need to be in place to capture the full benefits of these measures.

To check whether this is a feasible approach a number of affordability-adjusted scenarios were prepared by the consultants. The principle behind the scenarios is that in the '*survival'* period the heat demand is reduced drastically compared to the prevailing norm to bring it into line with the affordability constraints identified in the demand survey. The demand is reduced by decreasing comfort temperature, by only heating a part of the flat, and by disconnecting in average one third of the buildings (those with the lowest willingness-to-pay or willingness to organize themselves in a manner which reduces payment risk). In Table 9 the characteristics of this changing heat demand are described for Yerevan. Furthermore investments in existing heat supply networks are kept at an absolute minimum. In the *'recovery'* period the demand starts to increase and during the '*growth'* scenario demand comes back to the norm. If demand for centralized heating manifests itself in a competitive heat supply market, necessary modernization investments in centralized heating infrastructure would need to be made to ensure that the systems can function in a flexible, efficient way for at least 20 years. The analysis also includes the cost of the necessary investments in the natural gas infrastructure.

[22] See chapter 5.2.

Table 9: Changes in heat demand in Yerevan

	Heating days	Degree Days	Indoor Temp. °C	m² coverage	Heat demand	Connection	**Supply rate**
Normative	139	2,241	17	100%	100%	n/a	**100%**
Present situation	90	1,683	17	100%	75%	100%	**75%**
Year 1-2 Survival	90	1,323	13	67%	40%	67%	**27%**
Year 3-5 Recovery	90	1,683	17	75%	56%	75%	**42%**
Year 6-25 Growth	around 110	1,962	17	88%	77%	90%	**69%**

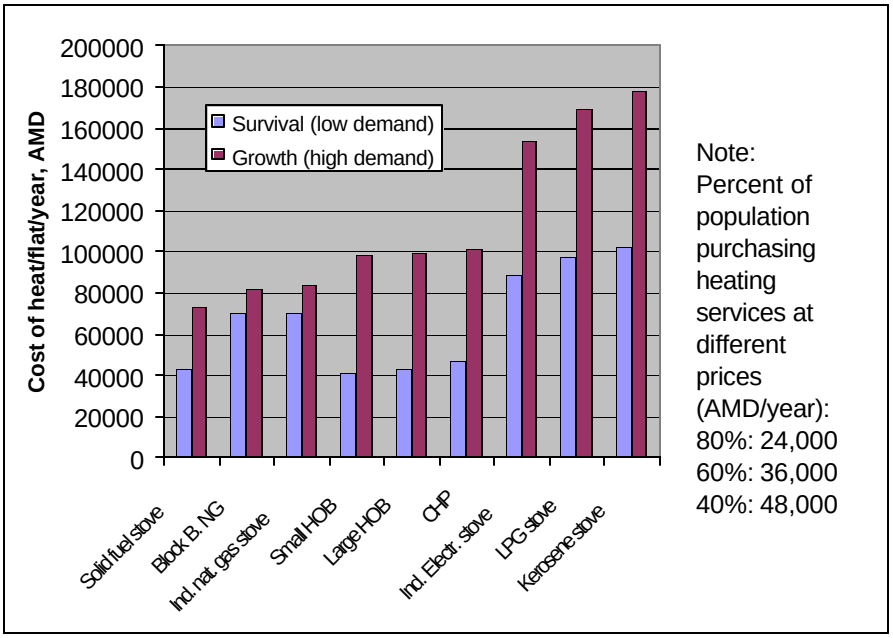
The affordability analysis results in the following conclusions:

- During the *survival* period most of the centralized heating solutions are among the least cost options, even though they are often more expensive than the average affordability level.
- Individual natural gas and block heating are not affordable for most of the population in the *survival* and *recovery* periods (0-5 years), but they become the cheapest solutions in the *growth* period over the longer term.
- Heating with an individual wood stove is always one of the cheapest solutions even though it cannot compete in cleanliness and convenience.
- In Yerevan, Charentsavan and Jermuk it seems possible to devise affordable heating options that will allow the centralized heating systems, with some technical and institutional measures, to survive for the initial 3-5 year period that will be necessary to attract providers of block heating options or financing for gas infrastructure investments or centralized heating system modernization. However, in the longer term when significant new investments need to be made, the centralized heating systems will be more expensive than individual NG and block heating.
- In Gyumri it does not seem possible to justify continued operation of the existing centralized heating system even during the immediate survival stage without very serious cuts in operating and maintenance costs, and the merger of the two heat supply organizations.

Figure 5 depicts the resulting annual heat costs in Yerevan in the (low-demand) survival scenario and the ("high" demand) growth scenario. It shows that with some additional investment to permit flexibility to provide a low level of heat, the centralized heat options can deliver low-cost heat to the consumer, comparable with wood stoves. In the short-term, it may be thus be possible to provide affordable heat with centralized heating by emulating how consumers use individual heating systems. The Armenia Urban Heating Strategy (UHS) proposes that if centralized heat supply from existing systems is to be provided during the survival phase, it should be done by restricting supply to only one or two room radiators in each apartment (instead of 3-4), delivering a temperature of about 17 degree Celsius (assuming reasonable insulation), and disconnecting the remaining vertical risers. Adopted for an entire centrally heated area, this should cut down considerably on fuel costs that have a cost share of 70-80%. Assuming robust contractual relations between suppliers and consumers, this more affordable level of service could be priced at its cost-recovery level and payment enforced with less social consequence. This is however only an interim strategy, suggested in order to buy time for putting in place the basic framework for a more market-driven heat supply. The large investments needed to extend the life of

centralized heating systems would make these systems much less competitive compared to autonomous and individual options, and expose them to a higher degree of market risk.

Figure 5 Yerevan: Average cost of heating for high and low demand (AMD/flat/year)



Note: Data for the growth scenario include cost of natural gas infrastructure.
Source: COWI 2002a, ERM 2001

The most important elements proposed in the UHS to make heat markets work are discussed in the next chapter.

6. INSTITUTIONAL AND REGULATORY FRAMEWORK TO SUPPORT THE IMPLEMENTATION OF THE UHS

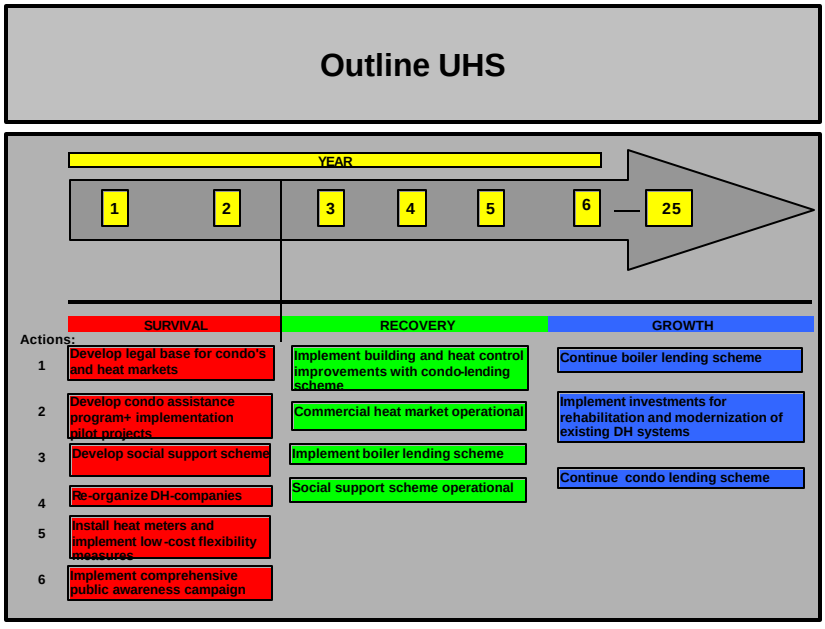
6.1 SUMMARY OF UHS PHASES AND ACTIONS

The proposed UHS consists of three phases:

- "Survival" during years 1 and 2: Support creation of market conditions for the commercial provision of heating by eliminating informational, regulatory, and "mind-set" barriers
- "Recovery" during years 3-5: Promote implementation of sustainable heating options
- "Growth" during years 6-25: Experience from Phases 1 and 2 generates large-scale demand for affordable heating solutions - decentralized heating systems and possibly investments for DH modernization.

In Figure 6 the main actions to be taken in each phase are summarized.

Figure 6: UHS: Phases and Main Actions



Especially in the first two phases the actions are "soft", concentrating of providing information to consumers and (potential) suppliers, eliminating legal, regulatory, and other institutional barriers to commercial and competitive heating options, enabling low-cost investment and setting the stage for more substantive investment in the third phase. This phasing is considered necessary

since the heat market in Armenia today is largely dysfunctional, with most consumers fending for themselves and the municipal heat suppliers de facto bankrupt, unable to supply more than 10% of the population with a service that keeps deteriorating and unable to collect more than a small fraction of the cost of centrally supplied heat. The UHS therefore has to overcome considerable barriers, ranging from lack of information, income, and creditworthy consumer institutions (condominiums) on the consumer side, to the lack of information on technical options or an enabling legal and regulatory framework for commercial provision of heating services by private suppliers. Each heating option carries its own risks (see Table 10), and the UHS needs to acknowledge them rather than simply recommend least-cost technologies.

Table 10: Risk dimensions of heat supply options

	Centralized heating	Autonomous building boilers	Individual electric stoves	Individual wood stoves
Institutional Complexity	Medium - high	High initially; medium later	None	Low
Commercial Risks	High	High initially, medium later	Low	None
Social risks	Medium	Medium	Low - medium	Low
Environmental/ Health risks	Low	Low - medium	Low	High

In the following the most important elements proposed in the UHS to make heat markets work are presented.

6.2 CONDOMINIUMS

The analysis in chapter 4 showed that heating in multi-apartment residential buildings in urban areas is best provided centrally, as a communal service (with the possible exception of individual natural gas stoves). At a minimum, each building should have its own central supply. The provision of central heating and other communal services is much facilitated if the dwellers are organized in order to make joint decisions and be able to act as a single entity in their commercial relations with a service providers.

About 50% of multi-apartment buildings in Armenia are currently organized as condominiums. The overwhelming majority of these condominiums, however, exist only on paper, and the few active ones encounter severe limitations in the services they can provide to their members due to institutional constraints (see chapter 4.5) and lack of access to financing.

Households in multi-apartment buildings therefore need support to organize effectively, for example as condominiums and other forms of community-based groups, and then to receive training to be able to manage their buildings and contract communal services. This would include, but not be restricted to the following:

- Legal changes to make condominiums more functional. This includes the transfer of common property of buildings from municipalities to condominiums, access by condo representatives to apartments (empty as well as occupied), right to develop and apply cost-allocation rules, more straight-forward and simpler decision making and voting mechanisms with an increased role for apartment owners; and a clear definition of those

eligible expenditures to be covered by fees and user charges and other contributions from all apartment owners;

- Establishment of special advisory centers and community activists for mobilizing urban households to form condominiums and other forms of community organizations, assisting them with their start-up and establishing "rules-of-the-game" (including through providing standard condominium documents and procedures), resolving conflicts, and facilitating access to better utility and community services and to affordable finance. The advisory centers should be part of an ongoing effort at least for the initial five-year period covering the survival and recovery phases of the UHS. It is foreseen that advisory centers should be established initially in all four cities beginning with Yerevan and expanded to Gyumri, Charentsavan and Jermuk;
- Access to financing for building improvements and possibly for investment in community infrastructure;
- Provision of income support to low-income and vulnerable households (through an enhancement of the family benefit program) to meet their condominium obligations;
- A sustained broad information campaign and public education program, drawing on experience from demonstration projects. It should inform the public about the need and benefits of the new approach, explaining the institutional structure for building management, rights and obligations of members of collective organizations and legal matters. Such a program could be channeled via TV, radio and the press as well as through public meetings in the cities' rayons. It is important to involve all stakeholders in the process, in particular with the use of the local self-government structures that are well suited to conduct the public meetings. The information campaign would also be useful in mobilizing demand for provision of heating services.

Such better prepared condominiums could then become effective counterparts for heat and other communal service providers. Experience from other countries (e.g. Lithuania) indicates that establishment and strengthening of condominiums is important and could be the centerpiece of a successful heating strategy. The UHS envisages the following responsibilities and roles:

(a) The condominium should be legally responsible for providing heating to all its members, either by operating its own boiler and internal distribution system or by contracting out this service.

(b) If contracted, the contract should describe the terms/conditions of delivery, tariffs, etc. Heat supply should always be metered, requiring a meter at the inlet to the building(s) constituting the condominium. The contract should clearly provide the supplier with the right to terminate heat supply to the connection if the contract is breached (for example for non-payment). It would also need to specify the rights of the customer. Whereas it appears that the existing legal framework allows for contracting with the condominium (the condominium being a legal entity), there are no examples of this happening. Instead, where service contracts with condominiums have been made already, they do not introduce the condominium as the legal purchaser and customer of heating services but merely as a billing and collection "agent" for the service provider;

(c) The condominium should be responsible for managing heat distribution inside the building, including maintenance of heating installations. This requires that access to the apartments is permitted in case problems with the heat installations arise;

(d) The condominium should be responsible for billing its members for communal services provided to the condominium. This includes allocating the total billing amount for heat consumption to the individual apartments;

(e) The condominium is responsible for collection of payment from individual households and is directly responsible for full and timely payment to the heat supply company. If the heat is not paid, the supply to the whole building is cut. To facilitate the cutting of supply to buildings in case of non-payment it is suggested that condominiums' main charters clearly stress the common responsibility to pay utility bills and that non-payments will result in sanctions for all condominium members.

As with the contracting of heat supply, the condominium may contract out some or all of the services mentioned above.

6.3 THE ENERGY REGULATORY FRAMEWORK

The provision of heating services to households so far has been one of two extremes: (i) Municipal centralized heating with non-metered supply according to norms, tariff setting and regulation of the heat supply company by the Energy Commission, and de-facto across-the-board subsidization (see chapter 3.1); or (ii) individually organized (and unregulated in the case of solid fuels) supply by each household. The UHS proposes a much more market-based and competitive provision of heating services to which the legal and regulatory framework for the sector needs to be adapted.

Centralized heating services (district heating) will continue to be regulated by the Energy Commission. The Commission is responsible for licensing, both technical and economic. It will provide the methodology for heat tariff setting and will approve heat tariffs proposed by suppliers. The tariff setting methodology needs to increase reliance on metering of consumption. It is recommended that heat tariffs consist of two parts, fixed part and variable part, depending on the actual consumption, mirroring the fixed and variable costs of providing heat. The Commission should also allow the provision of differentiated heat service levels, according to agreements between customers and suppliers.

Decentralized (autonomous) heating services will be based entirely on commercial contracts between supplier and customer. Suppliers will have to receive a technical license from the Energy Commission, ensuring that their equipment and supply systems meet safety and environmental standards. They may also be required to submit key performance data to the Commission which could help consumer protection groups to evaluate and disseminate this information. The Anti-monopoly Commission would need to ensure that sufficient service companies enter the market within a reasonable period of time to ensure competition. Service levels and prices should be negotiated between heat supplier and customer. Any issues of exploitation of customers and similar problems should be handled by the Anti-Monopoly Commission (or similar agency). Model contracts for this type of heating service have been developed and should be provided to suppliers and consumers as good examples for their use. In addition to building the capacity of consumer protection groups to benchmark performance, the Energy Commission could conduct consumer surveys and actively disseminate this information as a means of stimulating consumer awareness and competition. Also, the Commission may wish to issue guidelines which condominiums/customers can use in their negotiations with service providers.

6.4 COMMERCIALIZATION OF MUNICIPAL HEATING COMPANIES

In the future, all heating providers must operate on commercial principals. This holds especially for the existing heat supply providers who would be closed down if they fail to achieve

commercial viability. Being commercial means to build up market-based relations with consumers, suppliers and labor in a competitive environment. Important aspects of commercial operation include that

- Full cost recovery is achieved under the existing tariff framework;
- No operating subsidies are given to the heating companies[23];
- Heating companies bear no social obligations;
- The heating sector is opened up for private operators (regulated and un-regulated);
- Heating companies must be allowed to make a profit in a competitive environment.

With the affordability constraints and the central planning legacy of the sector, commercialization has a chance to be achieved only when the municipal companies supply to a reduced consumer base; i.e., those where marginal costs are lowest and affordability is adequate, following a set of strictly enforced rules:

- New contracts are to be signed with all customers which specify performance of the supplier (quantity and quality of heat supply) and obligations of customers (maintenance of internal piping, timely payment etc.) and sanctions for non-compliance;
- All contracts must be drawn up with legal entities in a way that makes it feasible to cut supply if customers do not pay (e.g. with condominiums for the supply to a whole building);
- Partial pre-payment should be required in order to supply buildings;
- All supply must be metered and heat billed based on actual consumption. Whether meters should be owned by suppliers or by customers with a corresponding obligation for maintaining the meters, needs to be decided. The consultants recommended that meters should be owned and paid for by customers under a subsidy scheme;
- The fixed part of the tariff should cover at least 25% of total costs unless specific information on the share of fixed costs indicates otherwise, and the variable tariff should reflect the marginal cost of supply;
- The heating system should be able to provide flexible heat so that people only have to buy what they need. Control valves at the customer installations are the most common way to achieve flexibility; if they are not installed, supplier and customer could agree on other measures to reduce consumption, such as lower supply temperature, shorter supply season and/or cutting out a number of radiator strings.

The UHS recommends that municipal heating companies should be converted within about one year to municipal holding companies owning the physical assets, and the existing debt burden as well as accounts receivable, but with no operational responsibility. A plan for management/ leasing of smaller parts of the system will be made by that time; the parts that cannot be taken over by management/lease contractors will continue to be operated by municipal operating companies.

6.5 FINANCIAL MECHANISMS

In the current economic environment in Armenia, households, condominiums, small entrepreneurs and municipal service providers have basically no access to financing. The implementation of the UHS does however rely on these economic actors having access to secure funds on affordable terms. While several banks have sufficient funds, the financial sector is reluctant to provide financing for ventures with perceived high risk. Heating services to multi-

[23] As mentioned above, targeted subsidies should be provided to low income and vulnerable consumers so that they may afford at least a basic level of heating service.

apartment buildings, where commercialization of these services poses high institutional risks, are unlikely to be an attractive candidate for private investment in the foreseeable future, particularly without sovereign or other credit guarantees.

The UHS proposes to establish lending schemes accessible for condominiums as well as for small private entrepreneurs who want to operate small boilers and sell heat to condominiums. An alternative might be to establish credit enhancement and risk sharing mechanisms that would provide comfort to financial institutions to extend credits from their existing funds. USAID is considering establishing such a guarantee fund. In addition, technical assistance would have to be provided to condominiums and entrepreneurs to enable them to develop bankable projects, and to banks for training their credit officers in assessing the risks of those clients. Micro-finance institutions which already have considerable experience doing business with small entrepreneurs in Armenia might be another kind of financial institution to participate in those lending schemes. In any case, potentially viable technical and institutional models for supplying heating services will have to be tested before many of these financing schemes can be advanced and mainstreamed.

6.6 SOCIAL AND ENVIRONMENTAL CONCERNS

To enable also poor households to take part in collective heat supply, the Government of Armenia should develop a targeted social support scheme. This scheme should replace the indirect across-the-board subsidies to district heating that are still prevalent, costing the government several million USD each year, while benefiting only about 10% of the population. The purpose of the suggested support scheme is to mitigate situations where the potential for chronic non-payment by low-income families within a condominium prevents the condominium from entering into economically efficient contracts for communal services. It is proposed to use the scoring method of the existing Poverty Family Benefit Program (PAROS) to identify beneficiaries, but it may be necessary to conceive of a different mechanism for distributing these benefits. The consultants recommend that the heat bills for families eligible under that program and receiving heat from collective systems will be paid to the condominium association for payment of its heating bill. The support could cover for example the fixed part of the tariff as subsidy to poor families. A precondition for this is that it is possible to regulate the heat in the apartment, so that the needy family can cut off the supply if they cannot afford to pay the variable part of the heat bill. It should be considered to introduce as a condition for heat subsidies that the needy family is organized in a condominium in order to promote the establishment of condominiums.

About 36,000 families with a score of more than 36 points, making them eligible for the Poverty Family Benefit Program, live in multi-apartment buildings in the four cities, about 6,670 of them in buildings currently connected to centralized heating systems. If these families received for example 25% of the cost of heating as subsidy, this would amount to about 100 million AMD, equivalent to about 7% of the current PAROS budget of AMD 16,700 million.

Until the UHS is implemented and even afterwards, a large number of families would still have to rely on individual heat sources. Especially the poor would still use wood or dung with the associated environmental problems and social costs. While the deforestation problems should decrease substantially with the implementation of the UHS, deforestation might not cease completely. The GOA should consider to subsidize the development or the capital cost of efficient wood stoves, particularly in the short-and medium term.

6.7 SUMMARY

The primary objective of the UHS is to facilitate access to affordable, safe and environmentally sustainable heating services by creating the market conditions for the commercial provision of these services. A secondary objective is to stimulate residents of multi-apartment buildings to organize themselves in a manner which would facilitate commercial provision of communal services on affordable terms. The UHS provides the strategic framework for the short and medium term development of the Armenian urban heating sector. The overarching tenet of the strategy is that the state has to get out of the business of providing heat and other communal services through either the direct operation of such companies or the extensive subsidization of such services. Instead its role is in the regulation and supervision of service providers, provision of information to enable the creation of markets, removal of other bottlenecks in the creation of markets and support of low-income families. The organization of apartment owners in condominiums or similar community-based organizations is considered a necessary requirement for a more efficient provision of affordable communal services in general and heating services in particular. The components of the UHS in the three phases are summarized in Table 11.

Table 11: UHS components by phases

Key Aspects	Survival (Y1+Y2)	Recovery (Y3-Y5)	Growth (Y6-Y25)
Regulation/market stimulation	Develop regulatory base for condominiums and heat market	Stimulate and support embryonic heat market actors	Market monitoring
Institutional	Restructure CH companies / full cost recovery/accountability Develop condominium assistance program and implement pilot projects, especially on demand side	Commercialization/ privatization of CH companies All collective heat consumers organized in condominiums and cooperatives	- -
Social	Develop social support scheme	Social support scheme operational	Social support scheme is phased out over suitable period
Technical All heating systems		If systems viable, introduce individual control & cost-allocation devices	Individual control is commonplace
Remaining DH systems	Disconnect risers to reduce supply costs, reduce heated area, install meters	Development dependent on market demand and full commercialization of DH entities	Improvements of CH infrastructure based on market demand and commercial financing
Other	Implement several building-level pilot projects	Simple demand side management measures implemented in buildings	Introduction of solar energy solutions for HTW
Gas Infrastructure	Coordinate with pilot projects		Comprehensive building insulation and improvements
Promotional	Implement comprehensive public awareness campaign Promote improved wood stoves	Continue information campaigns	-
Financial	Set up affordable financing schemes for condominium heat infrastructure and private heating service providers	Mainstream access to affordable financing by condominiums and private heating service providers.	Phase out any sovereign guarantees associated with condo and heating supply financing schemes

7. THE WAY FORWARD - WORLD BANK RECOMMENDATIONS AND NEXT STEPS

The strategy outline and actions as proposed in the consultants' reports give only a broad outline of the path towards the sustainable provision of heating services in Armenia. Concrete steps to take need to be decided upon by Armenian decision makers. Only then will the extent and the details of the work on all fronts for the coming years become clear. This includes firmer estimates of the costs of implementing the strategy and possible sources of financing.

The key recommendation which relates to all phases of the proposed strategy is to systematically correct market failures to enable consumers the access to affordable and clean heat services. The new role of the state is an enabling role, not the role of an implementer of technically-prescribed solutions. The GOA should set a clear policy regarding the role of the public sector in the heating sector, particularly it should define which actions merit being supported with public funds. With its restricted financial resources, the major role of the Armenian state in the heating sector, and more generally in infrastructure and communal services, should preferably be in the removal of barriers to enable a commercial and private-sector led provision of services. This includes the generation and dissemination of information (through demonstration projects), provision of credit to enable the population to adopt sustainable heating solutions, risk mitigation guarantees during the initial phases of market development, and special support to low-income families. There is also an important regulatory role of the state in network industries, including licensing and tariff setting. For decentralized solutions where competition is easier to establish, and entry and exit from contracts is less costly, a light regulatory approach consisting only of technical licensing is preferable in order not to choke private initiative, and to allow consumers and service providers to agree on the level of service, quality and price in private contracts.

The following actions are deemed necessary for the implementation of the UHS:

- A central implementation unit (CIU) should work with consumer organizations such as condominiums, and heat suppliers to generate interest in participating actively in the UHS implementation and in the proposed Urban Heating Project in particular. To avoid a top-down approach that is not anchored in effective community-based organizations, the CIU should be governed by representatives of potential stakeholders, have a lean, but high quality core staff, and contract out key activities such as community mobilization, technical design, communication, legal functions, etc. to entities best qualified to execute them effectively (NGOs may be best suited for community mobilization and formation of effective condominiums).
- GoA to embark on an information campaign to inform the public about the UHS and plans and time frame for its implementation. There needs to be a very firm commitment that the GOA will no longer engage in broad subsidization of centralized heating through payment of the natural gas bills for the existing centralized heat supply systems. The information campaign will be part of a more general public awareness campaign that will

focus on familiarizing the public with the GoA's condominium strategy and its role in improving the provision of communal services.

- Establishment of criteria for projects that may be eligible for receiving some public funding. It is proposed that during the survival phase public funding should concentrate on those areas where heat consumers are not connected to the centralized heating networks. This would enable a more thorough testing of institutional mechanisms and technologies that could then be scaled up during the next phases. Funding should also concentrate on projects and initiatives proposed by the private sector, i.e., consumers and private heat service suppliers.
- GOA to start intensive discussions with the municipalities that were directly involved in the preparation of the UHS about the details of the strategy and local implementation plans.
- Agreement on an action plan for the UHS survival phase. This includes
  - reviewing the heating zones examined during the preparation of the UHS and determining in which zones centralized heating might have a chance to survive without further subsidization
  - agreement on specific actions to take before the coming winter to bring payment capacity of the population and cost of heating in line (e.g., reducing the number of radiator strings - at a minimum, this should be done for at least one entire boiler house per city). This needs to include active participation of the existing heat consumers;
  - proposed methodology by the Energy Commission for heat tariffs supporting consumption-based billing for centralized heating; publication of a set of licensing requirements for non-regulated heat suppliers, concentrating on environmental and safety criteria;
  - inviting condominiums/other consumer groups and interested heat suppliers to participate in the implementation of pilot projects;
  - provision of targeted subsidies to low-income households that would facilitate the operation of condominiums and are in line with the existing social support scheme.

If the GOA and the World Bank agree on the financing of the UHP, some of the above actions could be supported during project preparation and receive financing under a Project Preparation Facility. The GOA should require all donors that any support in the heating sector should be in line with the UHS and coordinated through the GOA.

ANNEX 1: REFERENCES

List of Consultant Reports

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ANNEX 2: COMPARATIVE COSTS OF HEAT SUPPLY – TABLES IN AMD

Table 4a: Comparative Cost of Heat in Yerevan (in AMD)

Yerevan	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year
Zone 1=CHP	17192	1931	17311	1947	33673	1612
Zone 2=large HOB	10327	1205	14264	1661	24948	1260
Zone 3=small HOB	**9951**	**1139**	18320	2090	34622	1694
Zone 4= Reconnection to CH	14502	1634	13987	1573	24770	1194
Block 1 – HOB	11871	1331	**10525**	**1183**	**17390**	**847**
Block 2 – CHP	25126	2822	20239	2277	46829	2277
Individual electricity	28568	3207	27658	3108	31140	1513
Individual NG	16144	1815	13730	1540	22989	1117
Individual solid fuels	15471	1738	14996	1683	20773	1012
Individual LPG	31655	3553	30705	3449	33930	1650
Individual kerosene	33673	3779	32901	3696	35493	1722

Table 5a: Comparative Cost of Heat in Charentsavan (in AMD)

Charentsavan	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year
Zone 3=small HOB	**9556**	**1392**	14106	2052	25205	1612
Zone 4= Reconnection to CH	11890	1623	19270	2646	36957	2211
Block 1 - HOB	11376	1573	**10110**	**1397**	**16302**	**985**
Block 2 - CHP	23543	3251	18993	2629	43466	2629
Individual electricity	27995	3867	27223	3768	30092	1821
Individual NG	14621	2019	12583	1744	20219	1221
Individual solid fuels	14680	2030	14284	1975	19052	1150
Individual LPG	31101	4296	30309	4197	32960	1997
Individual kerosene	33237	4587	32604	4516	34721	2101

Table 6a: Comparative Cost of Heat in Gyumri (in AMD)

Gyumri	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year
Zone 2=large HOB	**10585**	2118	10683	2134	15372	1375
Zone 4= Reconnection to CH	12187	2437	14818	2662	24710	2002
Block 1 - HOB	**10585**	**2019**	**9457**	**1804**	**14660**	**1243**
Block 2 - CHP	21031	4004	17113	3262	38480	3262
Individual electricity	27183	5176	26610	5071	28647	2426
Individual NG	12444	2371	10980	2090	16342	1386
Individual solid fuels	13552	2585	13275	2530	16638	1408
Individual LPG	30329	5775	29736	5665	31615	2679
Individual kerosene	32604	6215	32149	6127	33633	2849

Table 7a: Comparative Cost of Heat in Jermuk (in AMD)

Jermuk	5-YEAR HORIZON		20-YEAR HORIZON			
	Normative heat demand		Normative heat demand		Reduced heat demand	
	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year	AMD/MWh	AMD/m²/year
Zone 2=large HOB	**10090**	**1661**	12741	2101	22218	1601
Zone 3=small HOB	11396	1804	19270	3047	37372	2563
Zone 4= Reconnection to CH	13275	2431	**9022**	1656	**13572**	1100
Block 1 – HOB	10486	1722	9417	**1546**	14719	**1051**
Block 2 – CHP	20754	3405	16915	2772	38797	2772
Individual electricity	27520	4516	26887	4411	29320	2096
Individual NG	13374	2195	11673	1914	18142	1298
Individual solid fuels	14047	2305	13710	2250	17746	1271
Individual LPG	30665	5027	29993	4917	32248	2305
Individual kerosene	32881	5390	32347	5302	34147	2442